Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

INTESTINAL OBSTRUCTION

A STUDY OF THE INFLUENCE OF THE BACTERIAL FLORA ON THE TOXEMIA OF ACUTE OBSTRUCTION

PAUL R. CANNON, LESTER R. DRAGSTEDT,
AND
CARL A. DRAGSTEDT

From the Department of Hygiene and Bacteriology, The University of Chicago

Complete obstruction in any region of the intestinal tract in animals produces a severe, rapidly developing toxemia. The symptoms are similar to those of acute mechanical ileus in man except that vomiting is a less noticeable feature. Death occurs in a short time after the onset of the toxemia unless the obstruction is relieved and all damaged intestine removed. It has been demonstrated both clinically and experimentally that the material which collects above the point of obstruction in the intestine is exceedingly toxic, and practically all investigators today regard the absorption of this material as responsible for the toxemia of acute obstruction. In previous studies by twc of us[1] it was shown that the toxic materials in intestinal contents both under normal conditions and in cases of acute obstruction may arise independently of food and in the absence of gastric juice, pancreatic juice and bile. It was further proved that the secretions of the normal intestinal mucosa are not toxic when absorbed from the peritoneal cavity. This was confirmed by Davis and Stone[2] who noted that fresh succus entericus did not produce toxic symptoms when injected intravenously into animals. When, however, the juice was permitted to stand and the proliferation of bacteria was not prevented by heat or preservatives, it rapidly became very toxic. The production of isolated closed segments of the intestine, as described by Stone, Bernheim and Whipple,[3] produces symptoms similar to those of complete obstruction at the same level. By making use of various modifications of this procedure, we have been able to show that the presence of

Received for publication May 3, 1920.

---

[1] Dragstedt, L. R.; Moorhead, J. J.. and Burcky, F. W.: Jour. Exper. Med., 1917, 25, p. 421. Dragstedt, L. R.; Dragstedt, C. A.; McClintock, J. T. and Chase, C. S.: Jour. Exper. Med., 1919. 30, p. 109. Dragstedt, C. A.; Dragstedt, L. R., and Chase, C. S.: Am. Jour. Physiol.. 1918. 46, p. 366. Dragstedt, C. A. and Moorhead, J. J.: Jour. Exper. Med., 1918, 27, p. 359.

[2] Jour. Exper. Med., 1917, 26, p. 686.

[3] Bull. Johns Hopkins Hosp., 1912, 33, p. 159.

bacteria in the lumen of the intestine is necessary for the production of the characteristic toxic substances, and in the absence of bacteria these substances are not formed. It seems highly probable that the principal toxic fraction in the contents of the obstructed intestine belongs to the group of poisonous substances which are produced by the action of bacteria on proteins or their split products. They are not toxins in the true sense of the word since they are not destroyed by heat nor will they lead to the production of antibodies when injected into animals.

The present study has been made to determine the relationship of the intestinal flora to the toxemia resulting from complete obstruction. If the toxemia is due to the absorption of poisons resulting from the action of proteolytic bacteria on proteins or their split products, it should not occur if proteolytic organisms are not present to break down nitrogenous materials.

TABLE 1

Series 1

Rat	Weight, Gm.	Diet	C–A Ratio	Days Survived Obstruction	Average Days Survived
B	130	Stock	1:99	8	6.66
C	98	Stock	5:95	3	
D	135	Stock	3:97	9	
11	150	Meat	90:10	11	8.0
7	312	Meat	99: 1	11	
15	140	Meat	91: 9	2	
12	170	Lactose	1:99	7	10.0
2	241	Lactose	3:97	11	
14	148	Lactose	1:99		

Stock Diet: oats, cabbage and carrots.
Meat Diet: groud beef, cabbage and carrots.
Lactose Diet: whole milk, whole wheat bread, lactose and cabbage.

It has been amply proved by Torrey,[5] Hull and Rettger,[6] and others, that the intestinal flora can be changed by diet. By feeding certain carbohydrates, particularly lactose and dextrin, the intestinal flora may be completely dominated by aciduric organisms with a diminution of the proteolytic types. This fact has been made the basis of the following experiments: White rats were fed on diets which changed the intestinal flora. Before operation the fresh feces from these rats were plated and the proportion of B. coli to B. acidophilus determined. This is expressed as the C-A ratio. Then under ether anesthesia a complete obstruction of the distal end of the cecum was made in each rat. In some of the rats the obstruction was produced by cutting the bowel, infolding and closing both proximal and distal ends. In others the obstruction was made by ligation with silk tape. The animals withstood the operation well and were eating, as a rule, within 24 hours. After operation they were fed the diets which had induced the type of flora desired.

---

[5] Jour. Med. Res., 1919, 39, p. 415.

[6] Jour. Bacteriol., 1917, 2, p. 47.

TABLE 2

SERIES 2

Rat	Weight, Gm.	Diet	C-A Ratio	Days Survived Obstruction	Average Days Survived
13	195	Meat	94:6	2.7	2.95
17	140	Meat	80:20	2.1	
19	298	Meat	99:1	5.0	
23	174	Meat	89:11	2.0	
20	220	Lactose	3:97	16.0	8.1
24	139	Lactose	1:99	5.4	
26	184	Lactose	5:95	5.0	
28	172	Lactose	1:99	6.0	

TABLE 3

SERIES 3

Rat	Weight, Gm.	Diet	C-A Ratio	Days Survived Obstruction	Average Days Survived
37	138	Meat	99:1	8.7	8.3
51	116	Meat	50:50	9.0	
43	117	Meat	50:50	5.0	
45	166	Meat	85:15	10.5	
42	204	Lactose	1:99	9.2	7.9
44	184	Lactose	1:99	2.0	
48	166	Lactose	1:99	12.5	

The following necropsy picture was typical of all the rats: The wounds were not infected and there was no evidence of perforation or peritonitis. The cecum and small intestines were greatly distended with gas and either hemorrhagic or markedly hyperemic. The contents of the cecum and ileum were foul smelling. The indol reaction with p-dimethylamidobenzaldehyd was intense. The hydrogen sulphid odor was usually pronounced. Stains of fecal emulsions from the ileum and cecum showed a great preponderance of gram-negative organisms and culturally the C-A ratio was approximately 90: 10. Even in the case of animals with an aciduric flora at the time of operation, the cecal contents at death were dominated by gram-negative proteolytic bacteria. In other words, there was a complete turnover from aciduric to proteolytic floras in cases of complete obstruction, in spite of the diets fed.

In this series the same general necropsy findings obtained as in the preceding series with the following exceptions: In rat 13, although the cecum and ileum were markedly hemorrhagic and injected and the contents were foul smelling, the indol reaction was negative. The C-A ratio was 99: 1. In the case of the lactose eaters that died the cecal flora was proteolytic, the C-A ratio being 97: 3.

The only striking feature in this series was the fact that in all the lactose eaters the C-A ratio at necropssy was reversed. The cecum and ileum were markedly hemorrhagic and distended and the indol reaction of the cecal contents was intense. In rat 44 the ligature had cut through and fecal material had penetrated into the peritoneal cavity, while in rat 42 the ileum was necrotic and easily torn.

TABLE 4

SERIES 4

Rat	Weight, Gm.	Diet	C-A Ratio	Days Survived Obstruction	Average Days Survived
51	170	Meat	90:10	10.0	11.5
47	200	Meat	97:3	10.0	
55	223	Meat	99:1	15.0	
53	234	Meat	95:5	11.0	
36	147	Lactose	3:97	12.75	10.0
38	137	Lactose	50:50	5.5	
30	130	Lactose	1:99	11.75	

TABLE 5

SUMMARY OF SERIES 1, 2, 3 AND 4

	Number of Rats	Average Weight	Average Days Survived Obstruction
Meat diet	15	188.8	7.82
Lactose diet	13	172.5	8.43
Stock diet	3	121.0	6.73

DISCUSSION

In these experiments all the animals dying with symptoms of acute intestinal obstruction with greatly distended cecum and ileum had at death an intestinal flora which was markedly proteolytic. In thirteen rats whose fecal flora at the time of operation had been of the aciduric type with a great preponderance of B. acidophilus, at death B. coli had almost completely gained the ascendancy although the diet had been conducive to aciduric development in normal animals. In no case did a rat with an initial aciduric flora have this type of flora at death.

It has been demonstrated by many workers that proteolytic organisms may produce toxic substances from proteins or their split products Normally a selective protective action of the cells of the intestine probably prevents their rapid absorption. This protective action may be lost under abnormal conditions, however, as in the case of obstruction with marked distention either from gas or residue through functional or anatomic injury to the absorptive mucosa. In this case absorption of toxic substances may take place faster than the liver can detoxicate them and toxemia and death ensue.

In our experiments one fact may indicate the reason for no more striking differences in the animals operated on. It was noticeable that at the time of operation the cecums of the rats on a meat diet were very small as compared with those of the rats eating bread, milk and lactose. The cecums of the meat eaters were almost empty and averaged about 0.5 cm. in diameter, whereas those of the lactose eaters were filled with material and were frequently 2 cm. in diameter. The latter rats were obviously at a mechanical disadvantage at the outset, but in spite of this fact the average period of survival was greater than that of the meat eaters. This bulky residue may have formed a barrier which made it impossible for the lactose to keep the aciduric organisms in the ascendancy, and with the turnover to a proteolytic gas-forming flora the added distention could lead to the hemorrhagic and frequently necrotic condition of the mucosa with a consequently hastened absorption of poisonous substances.

The fact that the toxemia arising from acute intestinal obstruction is always associated with the presence of a proteolytic flora in the intestinal contents above the point of obstruction is added evidence that the responsible poisonous substances are of bacterial origin. While the work of Torrey and of Hull and Rettger is confirmed by these experiments, it is not possible to prevent the onset of toxemia in cases of acute intestinal obstruction by dietary changes calculated to substitute an innocuous aciduric flora for a proteolytic one. However, it may be possible to delay the onset of a toxemia incident to postoperative adynamic ileus by feeding lactose or dextrin before the operation and thus implant an aciduric intestinal flora. In cases of incomplete intestinal obstruction with toxic symptoms and in others in which there is reason to believe that an intoxication of intestinal origin exists but without complete obstruction, it is probable that an implantation of aciduric organisms could be secured with marked benefit.

CONCLUSIONS

The intestinal flora of white rats can be effectively controlled through regulation of the diet. The feeding of a high protein diet produces a markedly proteolytic flora while the addition of lactose or dextrin in definite amounts brings about a predominance of aciduric organisms. The work of Hull and Rettger is confirmed.

The toxemia incident to acute intestinal obstruction is uniformly associated with the presence of a proteolytic intestinal flora and that irrespective of the nature of the flora before the obstruction is produced.

It is not possible to prevent the onset of toxemia in acute intestinal obstruction in animals by feeding diets which in normal animals bring about an aciduric intestinal flora. However, the onset of the toxemia may be delayed in proportion to the degree that the aciduric flora may be maintained, presumably developing simultaneously with the appearance of a proteolytic flora.